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Investigating Stable Potassium ($^{41}K/^{39}K$) Isotope Fractionation Associated with Microbial Illitization

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Clay minerals, also known as phyllosilicates or sheet silicates, are ubiquitous on Earth and Mars. Until recent decades, the conversion of smectite to illite (illitization) has been thought to be a purely abiotic process. More recent studies have shown that illitization can occur through the microbial dissimilatory reduction of Fe (III) found in the smectite octahedra. Iron reduction and liberation result in a charge imbalance that is satisfied by the uptake of K+, thus producing illite, and this process has been shown to fractionate Fe isotopes. We also know that in seafloor sediments, K isotopes can fractionate due to adsorption onto clay minerals and ion exchange during authigenic clay formation. Biology can also fractionate K isotopes by their incorporation into tissues and cells through absorption and diffusion across concentration gradients. This leads to a question: During microbial illitization, will we see a measurable K isotope fractionation?

In this study, we are investigating the fractionation of K-stable isotopes associated with microbial illitization by comparing the starting material (Fe nontronite) with the newly formed illite as well as thermogenic illite. We hypothesize that the illitization of nontronite clay by Fe-reducing bacteria causes a measurable and unique fractionation of K isotopes, where biogenic illite has a heavier isotopic composition than both Fe nontronite and thermogenic illite. We will also use cores from the Nankai Trough to attempt to make these same observations and interpretations but in natural samples. Our question is: If we observe a distinct K isotopic signature for the newly formed illite from lab-based experiments, can we use drill cores to make these same observations in nature?